

A Comparison of Forecasting Accuracy of International Spare Part Business to Domestic Spare Part Business

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Abstract:

One of the large automotive companies usually faced more spare part availability issues in international business compares to domestic business. So, the objective of the study is to check the forecasting accuracy of international spare part business in comparison with domestic spare part business in the concerned company. In this paper, the researcher has collected domestic as well as international spare part order data from one of the large automobile manufacturers to compare the spare part forecasting accuracy in both businesses.

Due to its spike's nature of orders in international business, it is difficult for spare part inventory planners to forecast the appropriate quantity. In this research, it is found that spare part forecasting accuracy is lesser accurate in international spare part business compares to domestic spare part business. The researcher compares the order deviations, some parts in fast-moving & medium moving category, a spike in different part categories, first fill ratio & MAPE values for both the businesses to arrive at conclusion.

Keywords: Spare part, forecasting, average, spike, standard deviation, part category, etc.

1. Introduction

Domestic automobile vehicle sale in India has grown up by 7.01 percent compound annual growth rate (CAGR) in five years i.e. from FY2013 to FY2018. In FY18, it was 24.97 million. In 2016-26, the Indian automotive industry is aiming to increase international business vehicle sales five times from 3.64 million in FY16. **IBEF automobile industry report (Mar 2019)**, In FY18, domestic auto component business in India was US\$ 51.20 billion. Out of which two-wheeler contributes to 79.61%, three-wheeler contributes to 3.51%, commercial vehicle & passenger vehicle contributes to 3.08% & 13.79% respectively. Till

2020-21, the domestic auto component business is expected to reach a US\$ 115 billion market size withholding 71 percent of total sales. International Business auto component business is expected to reach a US\$ 30 billion market size. **IBEF auto component industry report (Mar 2019)**

The above values force nation to focus on international business as a priority. Spare part business for domestic as well as international business contributes majorly to the Indian economy. Customers prefer to buy the vehicle of the company which provides equally good service. In service, spare part inventory management is the main area.

Every country wants to increase its international business. But when it comes to spare part inventory management for international business, the lead time to receive the part at the distributor end is more than domestic business. It is mainly due to material to be dispatch in a container by sea, the greater number of documentations & logistic lead time in the sea. It is more economical to dispatch in one container rather than small shipments.

In this research paper, the researcher has taken 15 months of order data of domestic as well as international business from one of the large automobile manufacturers in India & checks the same in view of spare part inventory management. The researcher checks the data through various types of analysis & checks whether there is any difficulty in forecasting accuracy due to container orders of international business.

This research paper will help to understand the difference between international & domestic spare part inventory management. It shows how & why inventory planning is more difficult in international business. The result shows a difference in spare part availability in domestic & international business when the same forecasting method applies to respective order data.

The remaining paper is arranged as below - section 2 focuses on a review of the literature. Section 3 refers to research methodology. Section 4 mentioned the comparative result of domestic as well as international spare part business concerning spare part forecasting. Section 5 refers to the conclusion, limitation, and future scope.

2. Literature Review

Most of the researchers focus on inventory modeling, even though more importance is given to forecasting in spare part **Hua H (2006). Andrea (2011)**, has developed a spare part planning framework. Andrea has mentioned the major 4 steps i.e. spare part classification, forecasting, inventory policy, and performance assessment of forecasting method.

2.1 Classification:

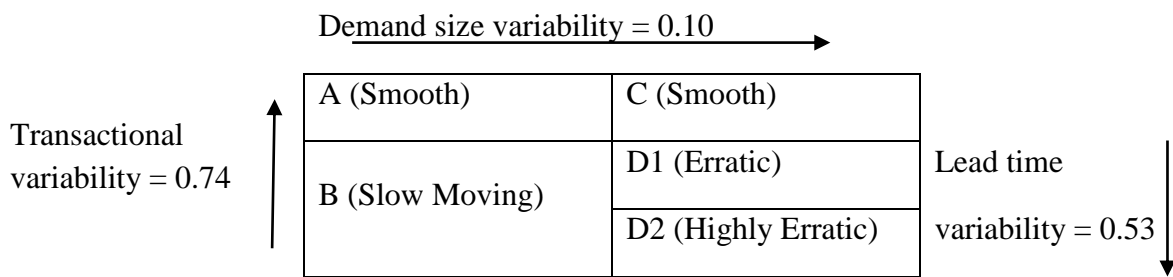
Syntetos (2010) made the framework in which he classifies the 3 stages of forecasting i.e. pre-processing, processing, and post-processing. In the pre-processing stage, the classification of items is described. In the processing stage, forecasting is elaborated & in the post-processing stage, adjustment to forecasting is explained. **Keyes (2009)** acknowledged that spare part classification improves the availability of spare parts & also reduces inventory cost. Spare part classification helps decision-making to manage inventory in a better way.

Kalchschmidt (2003) & (2006) filters the demand in stable series and irregular series. It is capable to segregate the peaks from stable demand. Kalchschmidt calculated the median & variability of demand for segregation. Variability is defined by using standard deviation.

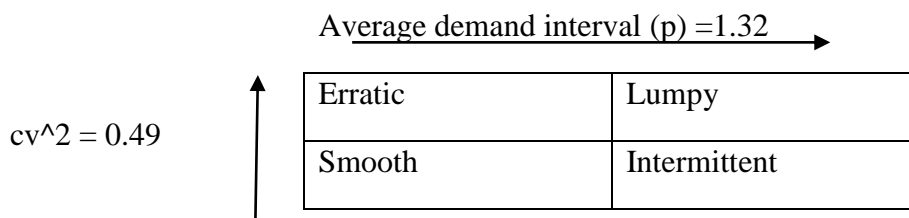
Mainly previous researchers classify the demand by below two ways. It helps to find out the erratic demand which is having a high standard deviation from a stable one. Erratic demand is very difficult to plan to compare to stable demand. **Andrea (2012)**

- 1) Standard deviation divided by average demand. It is also called the coefficient of variance.
- 2) Average interval between two spare part demands. It is also called the average inter-demand interval. This is done for classifying the slow mover demand. **Prof. Maurizio Faccio (2010), Ghobbar& Friend (2002), Syntetos & Boylan (2005), Eaves (2004).**

Further, **G.Heinecke (2013)** discussed below two classification old models in his research work. First, **Eaves (2002)** made a classification as below. He used transactional variability & demand size variability with lead time variability to categorize the parts. The vertical axes show the intermittence of demand. It shows the average lead times between successive demand occurrences. Horizontal axes show that the variability of demand size in combination with the degree of intermittence i.e. lumpiness.



Further, **Boylan (2005)** made a categorization in cluster & apply different forecasting methods for different classification clusters. He defines approximate rule in terms of fixed cut of value for the average inter-demand interval and squared coefficient of variation of the demand size. He made classification as below. For smooth classification, he used the Croston forecasting method and for the rest, he used SBA (Syntetos-Boylan) forecasting method.



2.2 Forecasting method

Simple average is the most commonly used forecasting method. Andrea has done the study in 10 different companies and defines the same. It is simple to understand and implement. **(Andrea 2012)** The researcher has mentioned many forecasting methods in his previous

research papers. Also, the researcher collected data from 136 dealerships and found that simple average is the most commonly preferred forecasting method in use.

3. Performance assessment of forecasting method:

In this stage, the researcher evaluates the performance of the forecasting method.

Below are the performance assessment methods.

A) Forecasting error

Forecasting error is a classical approach used to measure the error in actual vs forecasted quantity. This is useful for the goal of reducing the error. In this, researchers are analysing the tendency of overestimates or underestimates of demand. MAPE i.e. mean absolute percentage error is used to find out the percentage error. **Ali et al., (2015)**.

Table 1: Forecasting Error Calculation Methods Andrea (2011)

Measures of Distortion- This is considered the error sign.	Mean Error (ME)	$\frac{1}{N} \sum_{i=1}^n e_i$
	Mean Percentage Error (MPE)	$\frac{1}{N} \sum_{i=1}^n e_i / D_i * 100$
Measures of dispersion- This is not accounting the sign of error	Mean Absolute Percentage Error (MAPE)	$\frac{1}{N} \sum_{i=1}^n e_i / D_i * 100$
	Mean Absolute Deviation (MAD)	$\frac{1}{N} \sum_{i=1}^n e_i $
	Mean Square Error (MSE)	$\frac{1}{N} \sum_{i=1}^n (e_i)^2$

Generic indicator of forecasting error is divided into below categories: Error e_i = Actual – forecast qty

B) First Fill Ratio (FFR) / Service level (SL):

The first fill ratio indicates part availability percentage which is directly related to the end customer; hence it is a more common method being used by practitioners. The first fill ratio indicates a fraction of the total demand which can be dispatched from stock. For example, if customers placed orders for 100 lines and out of which 90 lines delivered in full qty then FFR is 90%.

C) Inventory Value:

It is mainly management interest criteria as funds are involved in it. **Andrea (2011)**.

3. Research Methodology

The objective of this study is to find out “spare part inventory planning” accuracy in international spare part business compares to domestic business.

Initially, the researcher asked for order data for 27 months, but only 15 months of data were available with the organization. The researcher collected the last 15 months' order lines data from one of the large automobile companies. Data is collected for domestic as well as international business. Then, the researcher has chosen old 12 months data & classified items in the fast mover, medium mover, slow mover 1, slow mover 2 category i.e. FMS1S2. These classifications are done based on order line frequencies. For fast mover, the researcher considered the top 60% items, for medium mover researcher considered next 60 to 80% items, for slow mover 1 researcher considered 80 to 95% items, & for a slow mover, 2 researchers considered 95% to 100% demand frequencies items.

Also, the researcher classified items in regular, irregular, sporadic category i.e. RIS. This classification is based on the number of months part has to order out of 12 months. Regular, the category is defined if the part has received the order in more than 8 months. An irregular category is defined if the part has received an order between 5 to 8 months. Sporadic is defined if the part has received an order in less than or equal to 4 months.

Then, the researcher calculated average, standard deviation, and standard deviation/average & checks the performance of domestic as well as international business. A researcher checks the business parameters i.e. average business value, the number of parts contributed for maximum business value, how many numbers of parts gets ordered in one year, how many order lines are received in a year, etc. Also, the researcher checks spikes in the overall business. It is important for planning. As spike increases planning method accuracy decreases. In the previous research paper, it is mentioned that spike cases in spare parts are difficult to predict and it badly affects inventory planning. Further, the researcher has made spike categories (low to high) to see the number of parts lying in each category. Spike is seen in FMS and RIS category cluster to compare the data. Finally, the researcher applied the same forecasting method on both the data sets & seen the accuracy in domestic as well as in international spare part business.

3.1 Company profile

Industry: Automotive.

Vehicle type: 2 & 3-wheeler.

Age of organization: 75 years

4. Summary related to international spare part business

Number of distributors placed a spares order: 110

Number of orders received in a year: 1410

Number of order lines received in a year: 313360

Number of parts ordered in a year: 17876

Total spare part business: INR 914 Cr / annum

5. Summary related to domestic spare part business

Number of distributors placed a spares order: 745

Number of orders received in a year: 388200

Number of order lines received in a year: 6289879

Number of parts ordered in a year: 20658

Total spare part business: INR 2420 Cr / annum

3.2: Planning details

Forecasting method used – Simple average of last 12 months

Inventory policy – Periodic review inventory policy with order-up-to levels

Spare part classification – FMS & RIS (Fast Medium Slow mover & Regular-Irregular Sporadic)

Assessment of forecasting method – MAPE (Mean Absolute Percentage Error), FFR (First Fill Ratio)

Other inventory parameters checked – Average, Standard Deviation, etc.

Software used for analysis – Microsoft excel office 365

4. Result:

International business order Vs Domestic order comparison for 12 months data given below. The below analysis is with the context of forecasting.

A. Deviations in domestic and international order data.

Table 2: Business Comparison

	International Business	Domestic
Avg monthly Business Value in CR (INR)	76	202
SD Value in CR (INR)	66	92
SD/Avg (deviation in order value)	86%	46%
Part no ordered	17876	20657
Order lines ordered in per month	26113	524157

5. **SD / Avg score is lower the better.**

B. **The number of parts contributed to 80% of order lines**

Fast mover, medium mover & slow mover parts are based on the number of order lines. It is defined that the top 60% are a fast mover and then 60 to 80% are a medium mover. Below is the summary of the number of parts contributed to 80% of order lines.

Table 3: Fast Mover and Medium Mover parts contribution in overall business

	International Business	Domestic
% no of parts in F & M category	34%	19%
% no of order lines	80%	80%
% business value	90%	86%

6. **% no of parts in the F & M category is lower the better.**

C. **Spike category and number of parts**

Below is the part summary as per the spike category. Spike is defined as standard deviation/average. If value increases spike also increases.

Table 4: Number of parts vs spike category

Spike category	International Business	International Business	Domestic	Domestic
Less than 0.5	3%		32%	
0.5 to 1	20%		26%	
1 to 2	39%	77%	24%	42%
2 to 3	21%		9%	
3 to 4	17%		9%	
Grand Total	100%		100%	

7. **% no of parts in grater than 1 spike category score is lesser the better.**

Further, spike cases i.e. more than 1 case shown below as per FMS & RIS cluster for international as well as for domestic business.

Table 5: Spike more than 1 in part categories (i.e. more than 100%)

International Business					Domestic				
Category	R	I	S	Total	Category	R	I	S	Total
F	3%	0%	0%	13%	F	0%	0%	0%	0%
M	8%	2%	0%		M	0%	0%	0%	
S1	2%	17%	4%	64%	S1	1%	0%	0%	42%
S2	0%	1%	36%		S2	8%	11%	21%	
Total	13%	19%	41%	77%		9%	12%	21%	42%

8. % no of parts having greater than 1 spike category is lower the better.

D. Forecasting Accuracy as per First Fill Ratio

The researcher forecasted the parts by simple average method & checks the % part availability on the order line level. In the below table % part availability is shown on total parts level and also as per FMS category.

Table 6: Planning method accuracy i.e. Parts availability

	International Business	Domestic
Total parts	69%	80%
Part category wise break up given below		
Fast mover	82%	83%
Medium Mover	66%	82%
Slow Mover 1	47%	77%
Slow Mover 2	19%	59%

9. % part availability score is higher the better

E. Forecasting Accuracy as per MAPE

The researcher checks the simple average forecast method accuracy by MAPE (mean absolute percentage error).

Table 7: Planning method accuracy by MAPE

	International Business	International Business	Domestic	Domestic
Row Labels	MAPE		MAPE	
0%	9%		1%	
less than 25%	14%		1%	
25 to 50%	15%		3%	

50 to 80%	17%	41%	19%	80%
80 to 120%	17%		44%	
120 to 150%	7%		18%	
150 to 180%	6%		8%	
180 to 200%	2%		3%	
more than 200%	12%		5%	
Grand Total	100%		100%	

10. MAPE score in between 50% to 150% higher the better

1. Conclusion, Limitation & Future scope:

Total 5 different types of the result shown in the result section which confirms that forecasting in international business is more difficult than domestic business. It shows the accuracy of a forecasting method in international business is lesser accurate than domestic and what is the reason for same i.e. spikes in businesses.

In result A, i.e. deviations in domestic and international order data, it is seen that international business has a 40% more spike than domestic business. International business has 86% value of standard deviation divided by average whereas domestic has only 46%. It means part line planning for international business is more difficult than domestic business. As discussed with the business team, it happens mainly because of dealer combines order in to reduce logistics cost, more logistics lead time, a lesser number of vehicles in international business compare to domestic business, and heterogeneous products, etc.

Result B table is about how many part lines contributed to 80% of order lines. These are very crucial part lines & management is mostly interested in the forecasting of these lines as surety of getting orders in it are very high & it contributes a significant amount of order value. In international business, 34%-part lines get ordered 80% times vs only 19% parts in domestic. More part lines need to be a plan in International Business to achieve 80% order lines when it compares to domestic business.

As spike (i.e. standard deviation / average value) increases, it will affect badly on inventory planning. Inventory forecast will be shown on the higher side due to few months spike cases. Result C, table 4 shows that in international business 77% parts has spiked more than 1 value (i.e. in percentage it is more than 100%), whereas in domestic it is only for 42% parts. In table 5, it is elaborated category-wise. In international business, 13% fast & medium mover parts having spikes more than 100 percent, whereas in domestic, none of the parts from these categories having spikes more than 100%. In international business, 64% slow mover parts having spikes more than 100 percent, whereas in domestic only 42% parts from these categories having spikes more than 100%. Due to its spike nature of orders in international business, forecasting method accuracy will get badly affected. It is in line with previous researchers & same is seen in this research,

In result D table 6, it is seen that, when the same forecasting method is used on respective order data, then part availability in international business for overall parts are 69% vis a vis 80% in domestic. For the medium mover category, part availability in international business

is 66% whereas in domestic it is 82%. When the researcher checks part availability in slow mover 1 and slow mover 2 parts, it is 47% & 19% respectively in international business, whereas in domestic it is 77% & 59% respectively.

The researcher also checks the accuracy of the same forecasting method by MAPE method to define which business has lesser accuracy in forecasting. MAPE will give a value of actual order against forecast quantity. It is seen in table 7 that, in international business, only 41% parts lying in 50% to 150% category whereas in domestic 80%-part lines are in these categories.

All the above analysis shows that forecasting accuracy in international spare part business is lesser than domestic spare part business.

The limitation of this study is as follows. Due to the time limit and data sharing restrictions, current research is done in only one company. A similar type of research can be done in different companies as well as in different industries to get more insights into the business.

In future research, researchers can do a comparative analysis between international and domestic businesses for their inventory management practices. Researchers can find out manpower and software current maturity levels in both the businesses to understand the gaps & make the action points to improve upon.

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